Periodic Properties of the Elements

Objectives

- Analyze trends within groups and periods on the periodic table of elements. (Exploration 1)
- Determine the identity of seven mystery elements based on periodic table trends. (Exploration 2)

Description of Activity

In this activity, a partial periodic table is provided. You will select an element and evaluate the element's physical properties. After selecting the element, you will analyze the patterns of these properties as they occur across a **period** as well as trends that exist down a **group.** You will identify several mystery elements by investigating and interpreting periodic trends. Remember that valence electrons are defined as the electrons in an atom's outermost orbitals, which are the electrons involved in chemical bonding. Transition metals have a tendency to form more than one cation, and the trend associated with the number of valence electrons is therefore less predictable for the transition elements.

Jump Start

1. Dmitri Mendeleev organized the periodic table according to increasing atomic mass. How is the modern periodic table organized?
2. Explain the difference between a chemical property and a physical property.
3. Define ***periodicity*** as it relates to the organization of elements on the periodic table.
4. What defines a group of elements?

Exploration 1: Looking for Trends

Procedure:

Part I

1. In Exploration 1, select the element from period 2, group 1, on the periodic table. When selected, the group and period number will be highlighted by red circles.
2. Select the element's period (row) number, represented by a red circle.
3. Record the element's properties from the list provided in part 1 of **Table 1.**
4. Note that you can select various periodic trends for the element and period. These trends appear as graphs on the right side of the screen.
5. Observe the graph for atomic radius (pm). Describe the relationship between atomic radius and atomic number for all the elements in period 2, and record these observations in part 1 of **Table 2** in the row labeled *Trends Across Period 2.*
6. Select *Atomic mass (amu).* Observe the graph, and evaluate the trend for atomic mass as a function of increasing atomic number. Record your observations in **Table 2** in the row labeled *Trends Across Period 2.*
7. In a similar fashion, evaluate the trends for the number of valence electrons of the main group elements, electronegativity, density (g/cm^3), and melting point (°C) as a function of increasing atomic number for period 2. Record observations for each trend in **Table 2** in the row labeled *Trends Across Period 2.* When finished, select *Close* to return to the periodic table.
8. Repeat steps 1–7 for the group 1 elements in periods 3, 4, and 5, respectively. Record each element's properties in part 1 of **Table 1,** and each period's trends in the appropriate row of part I, **Table 2.**

Part II

9. Select the element that resides in period 2, group 1. Choose the element's group (column) number, represented by a red circle.
10. Record the element's properties in part 2 of **Table 1.**
11. Select the graph buttons, and observe the graph trends for atomic radius (pm), atomic mass (amu), number of valence electrons, electronegativity, density (g/cm^3), and melting point (°C). Record these trends in part 2 of **Table 2** in the row labeled *Trends Down Group 1*.
12. Repeat steps 9–11 for the period 2 elements in groups 2, 13, 14, 15, 16, 17, and 18. (There are no transition elements in period 2, so there is a gap in the group numbering between 2 and 13.)

Observations and Analysis

Table 1

Part 1: Period Number	Symbol	Atomic Number	Atomic Mass (amu)	Atomic Radius (pm)	Density (g/cm^3)	Electro-negativity	Melting Point (°C)	Valence Electrons
2								
3								
4								
5								
Part 2: Group Number	**Symbol**	**Atomic Number**	**Atomic Mass (amu)**	**Atomic Radius (pm)**	**Density (g/cm^3)**	**Electro-negativity**	**Melting Point (°C)**	**Valence Electrons**
1								
2								
13								
14								
15								
16								
17								
18								

Table 2

Part 1	Atomic Radius (pm)	Atomic Mass (amu)	Number of Valence Electrons	Electro-negativity	Density (g/cm^3)	Melting Point (°C)
Trends Across Period 2						
Trends Across Period 3						
Trends Across Period 4						
Trends Across Period 5						
Part 2						

Trends Down Group 1						
Trends Down Group 2						
Trends Down Group 13						
Trends Down Group 14						
Trends Down Group 15						
Trends Down Group 16						
Trends Down Group 17						
Trends Down Group 18						

1. What is the trend in the number of valence electrons as you move down a group? Across a period?
2. Interpret the general electronegativity trend that exists for elements across the same period. Explain why this trend occurs.
3. Analyze the trend in atomic radius for elements located within the same group on the periodic table. Explain this trend.

Exploration 2: Identifying the Mystery Elements

Procedure

1. In Exploration 2, select the first mystery element.
2. Notice that a few of the properties are missing in the list provided. Record the known physical properties for the mystery element in **Table 3.**
3. Return to Exploration 1 to view the periodic table. Based on the properties provided in step 2, use graph trends and data from **Table 1** and **Table 2** to identify the mystery element.
   [**Hint:** Mystery elements may reside in any group or period. You may need to plot a variety of trends to determine the identity.]
4. Repeat steps 1–3 for the remaining six mystery elements. Record all data in **Table 3.**

Observations and Analysis

Table 3

Mystery Element	Atomic Radius (pm)	Density (g/cm^3)	Electro-negativity	Melting Point (°C)	Element Name

1. Describe the problem-solving process that you used to determine the identity of the seven mystery elements.
2. Why was the number of valence electrons excluded from the mystery element data provided?

Conclusions

With information gained in this activity, discuss the patterns that exist in the periodic table. Mendeleev's original periodic table was published in 1869. Do you think Mendeleev's tables, which were based on atomic mass rather than atomic number, accurately predicted the modern positions on the periodic table. Explain.

Inquiry Extension

Suppose you are a chemist that has recently discovered a new element. What information do you need to place this element on the periodic table? Besides periodic table trends discussed in this activity, describe other properties that could be used to position elements on the periodic table.